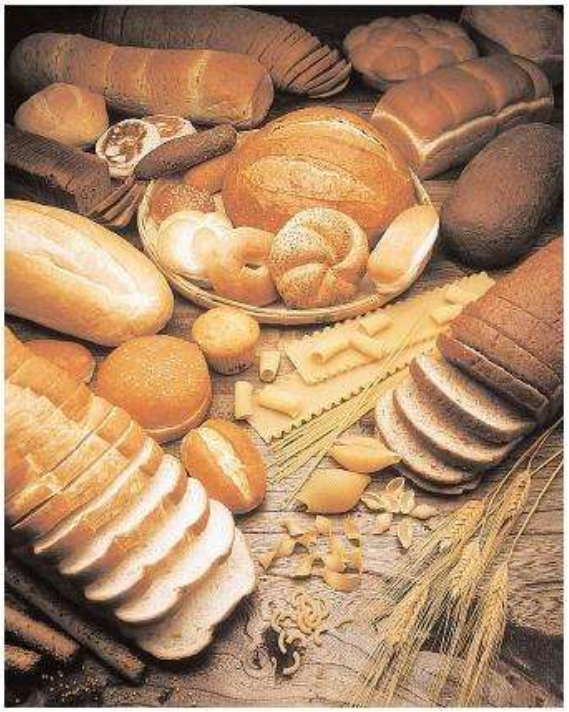
# CARBOHYDRATE CHEMISTRY

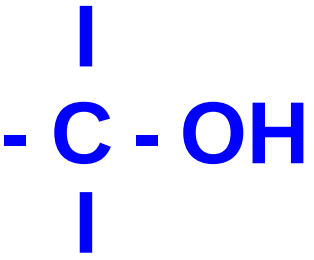



# Carbohydrates

- *Carbo(C)……Hydrate*

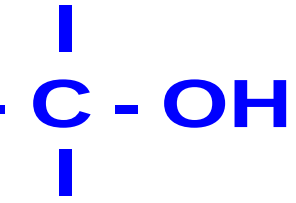
**(hydrates of carbon)**

- Most have general formula $C_nH_{2n}O_n$

$(CH_2O)_n$ or 

# Carbohydrate Definition

**polyhydroxyaldehyde or polyhydroxyketone**, or a substance that can be hydrolyzed to form these compounds

$(CH_2O)_n$ or 

# Functions of Carbohydrates

- Structural role

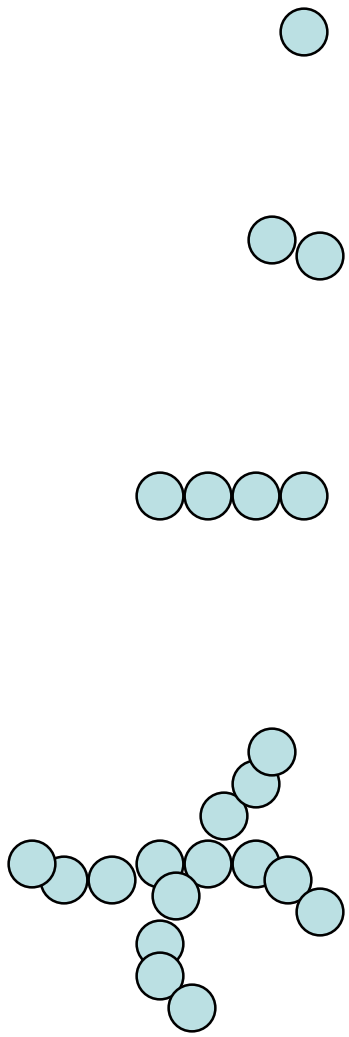
- Energy source

- **Importance:**
- 1- Energy source; storage and labile
- 2- Structural components cell wall, cell membrane
- 3- Glycoconjugates
- 4- Lubricants

# Solubility

- The presence of the **hydroxyl groups** allows carbohydrates to interact with the aqueous environment and to participate in hydrogen bonding, both within and between chains

# Classification of Carbohydrates



Monosaccharides - simple sugars

- Disaccharides - 2 monosaccharides covalently linked.

Oligosaccharides – 3 to 10 monosaccharides covalently linked.

Polysaccharides - more than 10 monosaccharide units covalently linked.

# MONOSACCHARIDES

# *Monosaccharides*

A monosaccharide is a carbohydrate that cannot be hydrolyzed to a simpler carbohydrate (simple sugar)

- biologically important ones are:
  - ***Glucose**: most common sugar, also blood sugar*
  - ***Fructose** : fruit sugar*
  - ***Galactose**: sugar found in milk*

# Properties of Monosaccharides

- Simplest of carbohydrates
- Sweet-tasting
- Dissolve in water
- Straight chain or ring structure
- All in body are of the D type
- Reducing sugars

# Monosaccharide Classification

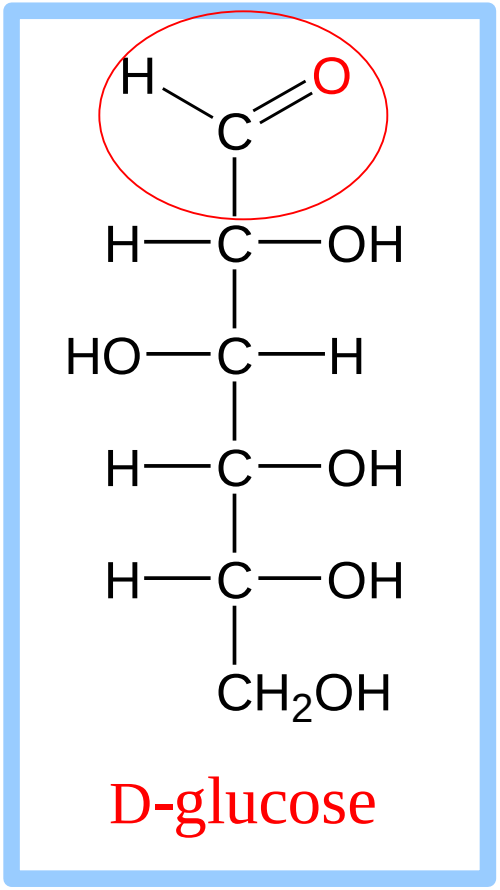
- 1- On the basis of the numbers of carbon atoms
- 2- On the basis of the functional group.

# 1. According to number of carbons

| | | |
|---|---|---|
| • 3 carbons | triose | |
| • 4 | tetrose | |
| • 5 | pentose | ribose |
| • 6 | hexose | glucose,fructose galactose |
| • 7 | heptose | |
| • 8 | octose | |
| • 9 | nonose | |

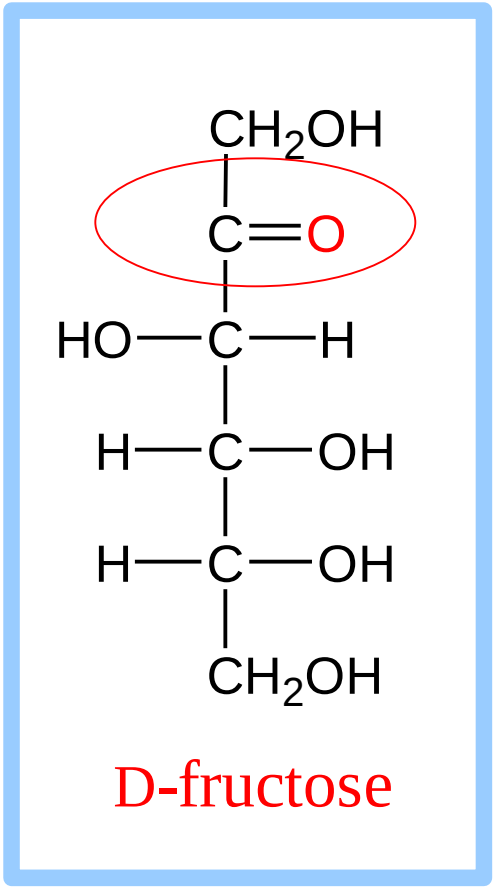
# 2.According to functional group

Aldoses have an aldehyde group at one end.




D-glucose

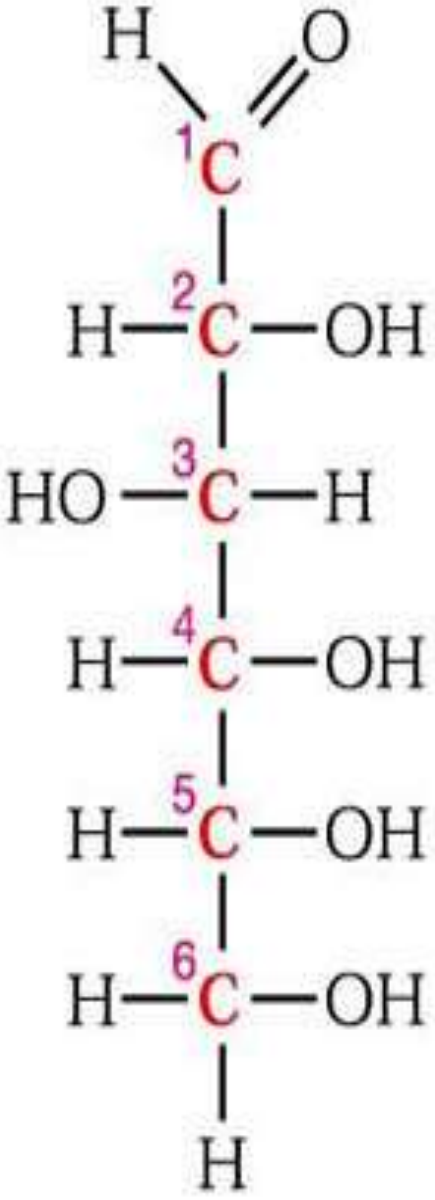
Ketoses have a keto group, usually at C2.



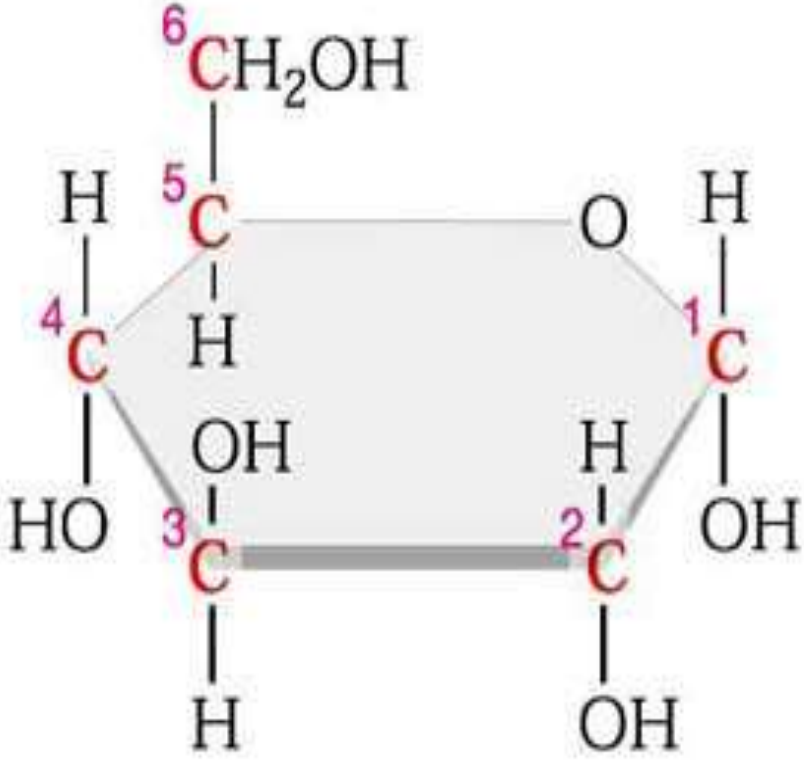

D-fructose

Structure of glucose, the most common sugar found in humans and other vertebrates. Monosaccharides can exist in both linear and ring forms [ring form is much more common]. Note the C-numbering.

Glucose

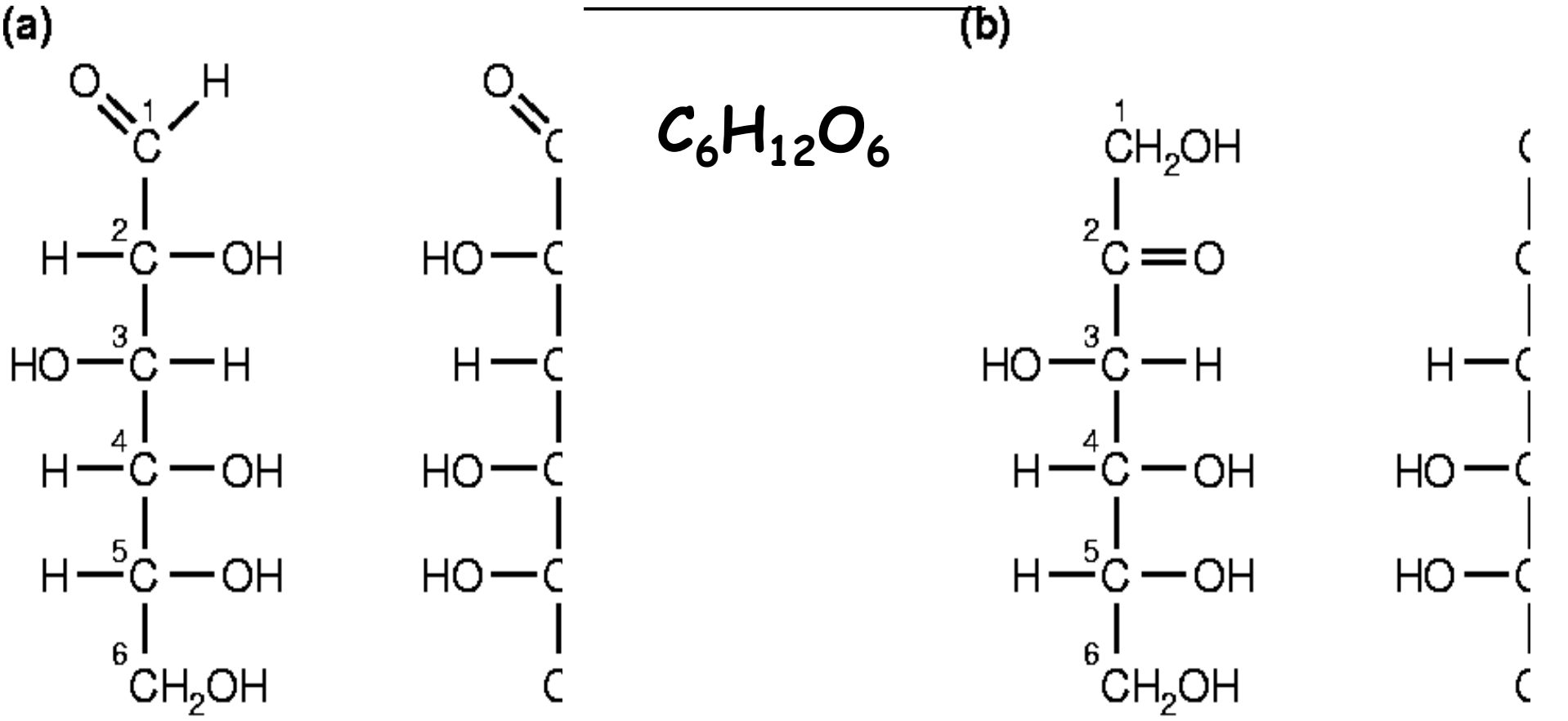



linear




ring
(more stable)

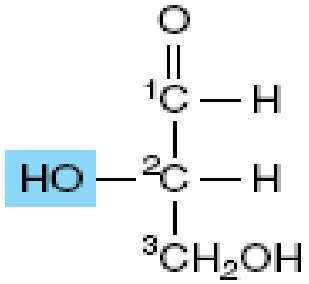
# ISOMERS: same chemical formulae



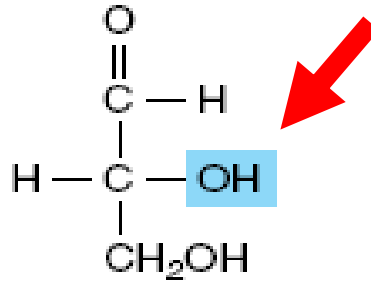
# ISOMERS OF MONOSACCHARIDES

## 1) D- and L- isomers

= mirror images
(enantiomers)

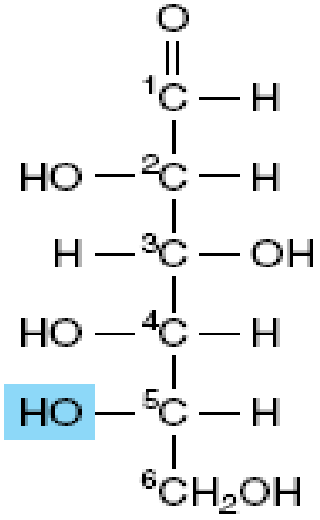


L-Glycerose
(L-glyceraldehyde)

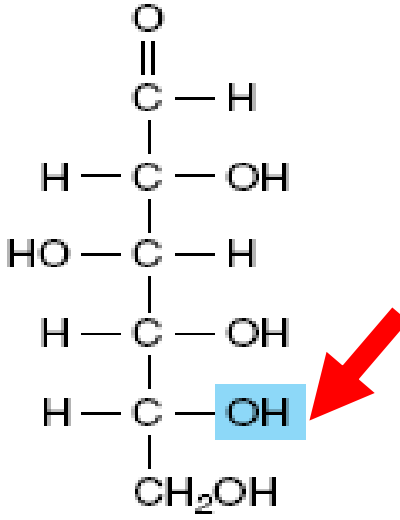


D-Glycerose
(D-glyceraldehyde)

**nature important:**
**D-monosaccharides**



L-Glucose

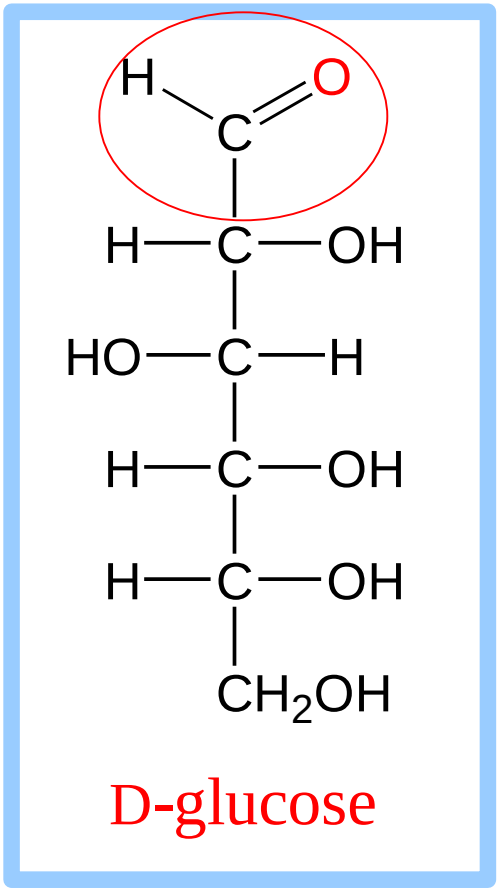


D-Glucose

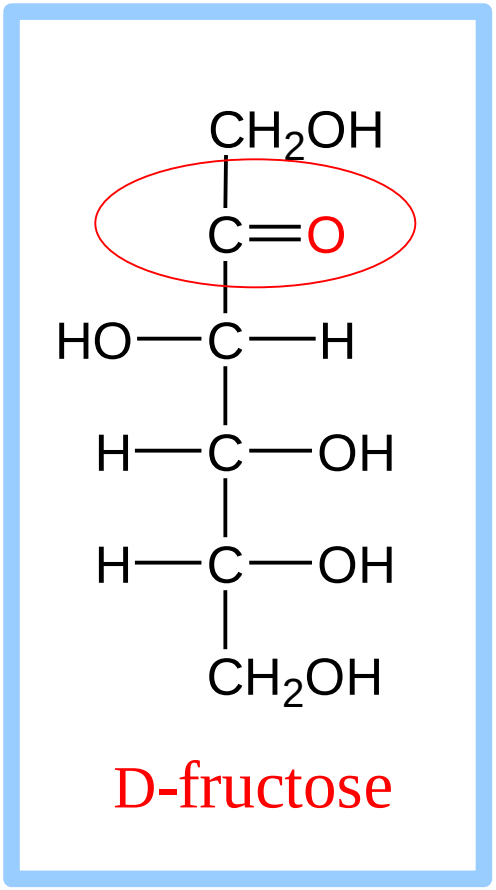
# D & L Conformations

- **Monosaccharides can exist in either of two configurations, as determined by the orientation of the hydroxyl group about the asymmetric carbon farthest from the carbonyl group..**

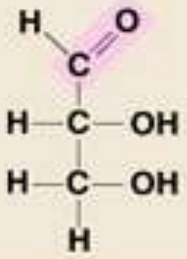
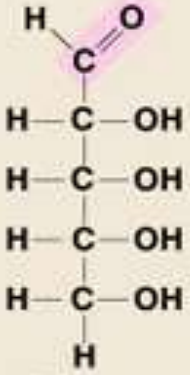
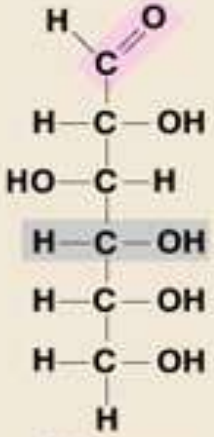
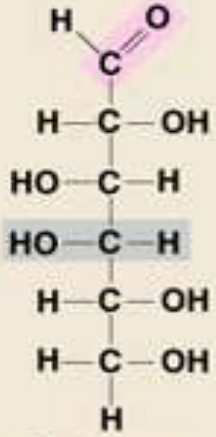
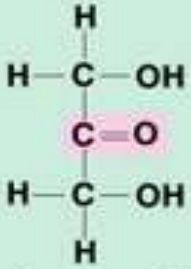
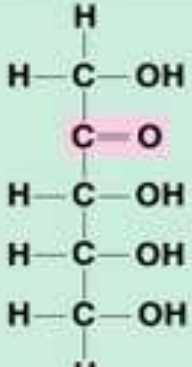
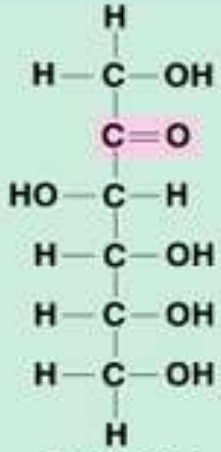
# 2)Aldoses and Ketoses




D-glucose

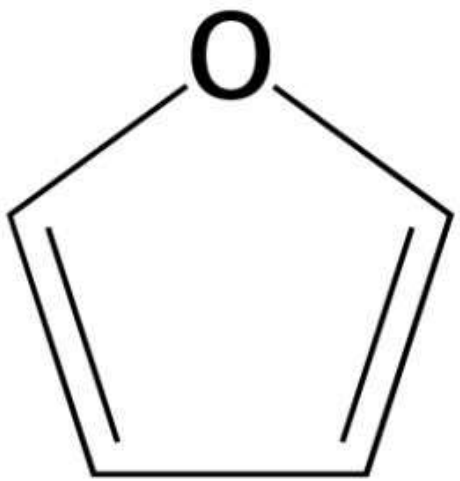



D-fructose

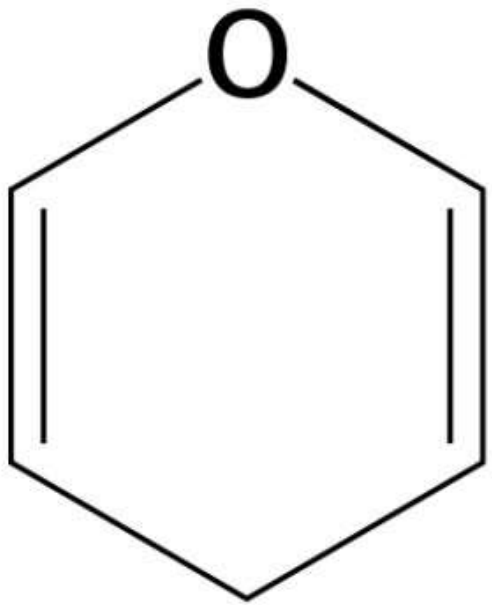
| | Triose sugars ($C_3H_6O_3$) | Pentose sugars ($C_5H_{10}O_5$) | Hexose sugars ($C_6H_{12}O_6$) |
|---|---|---|---|
| Aldoses |  Glyceraldehyde |  Ribose |  Glucose  Galactose |
| Ketoses |  Dihydroxyacetone |  Ribulose |  Fructose |

# 3) pyranoses and furanoses

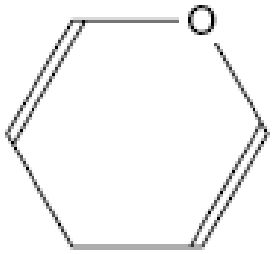
**Sugars Prefer To Be Cyclic in solutions**



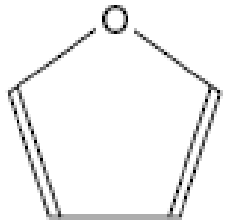

**Furan**




**Pyran**



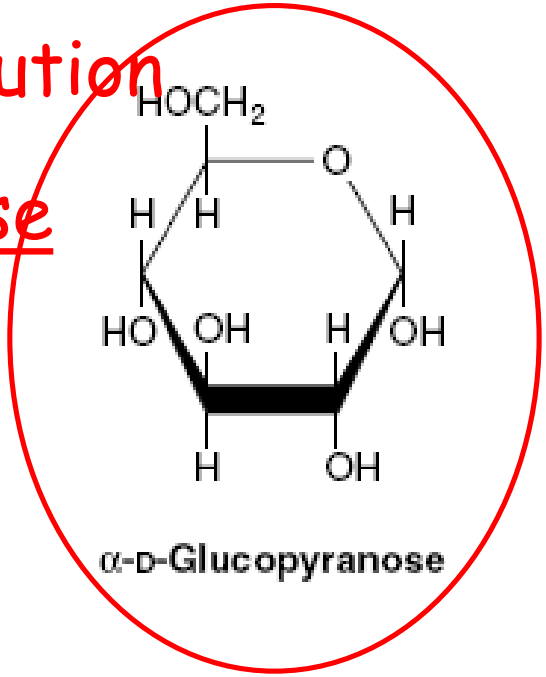

Pyran



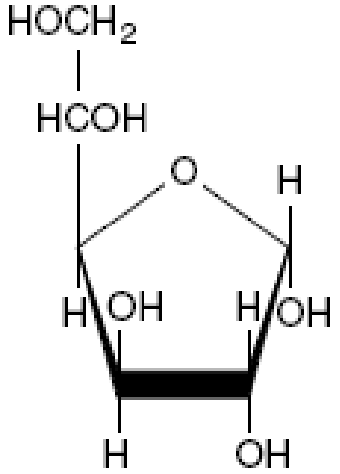

Furan

99% of Glucose in solution

is found in pyranose form



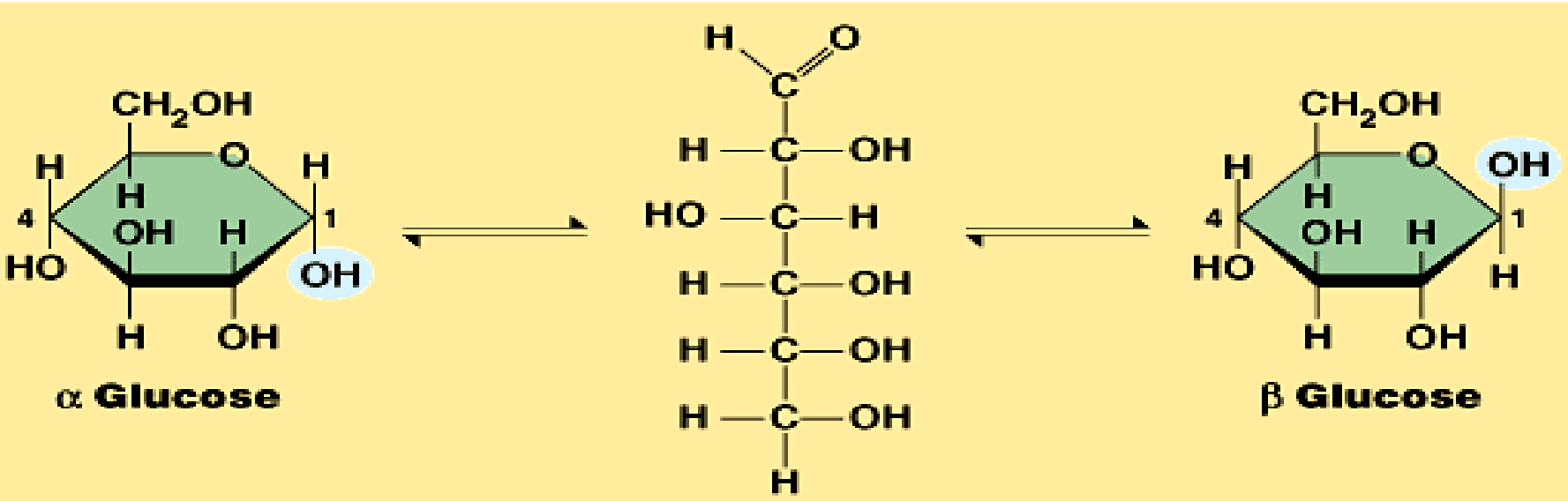

α-D-Glucopyranose




α-D-Glucofuranose

# 4) α and β anomers

only <u>cyclic</u> molecules

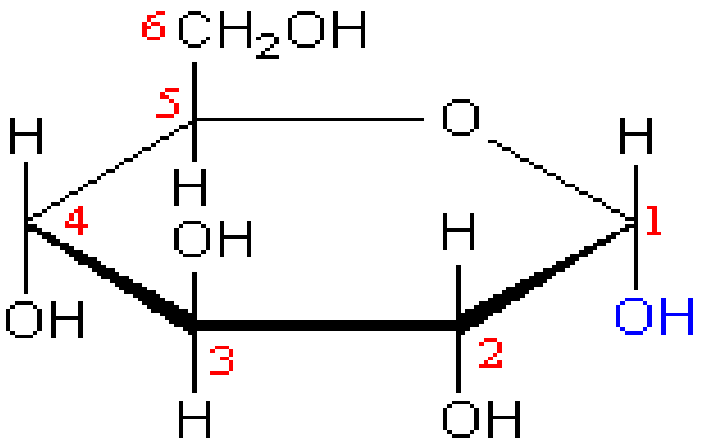



(a) α and β glucose ring structures

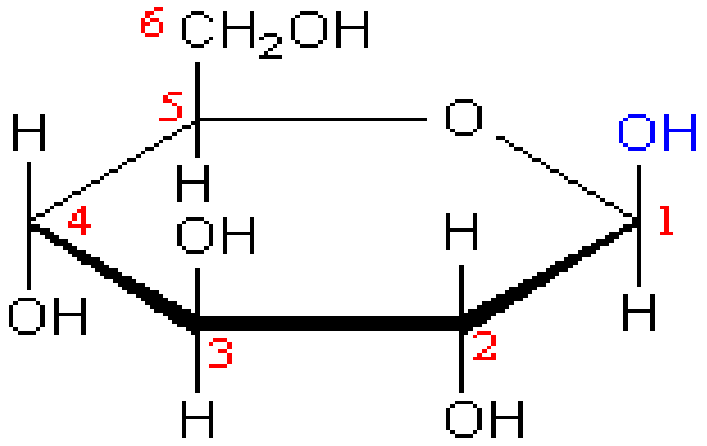
* OH orientation of anomeric carbon is the basis of this classification.

β anomer : Same side with the side chain( the last carbon atom)

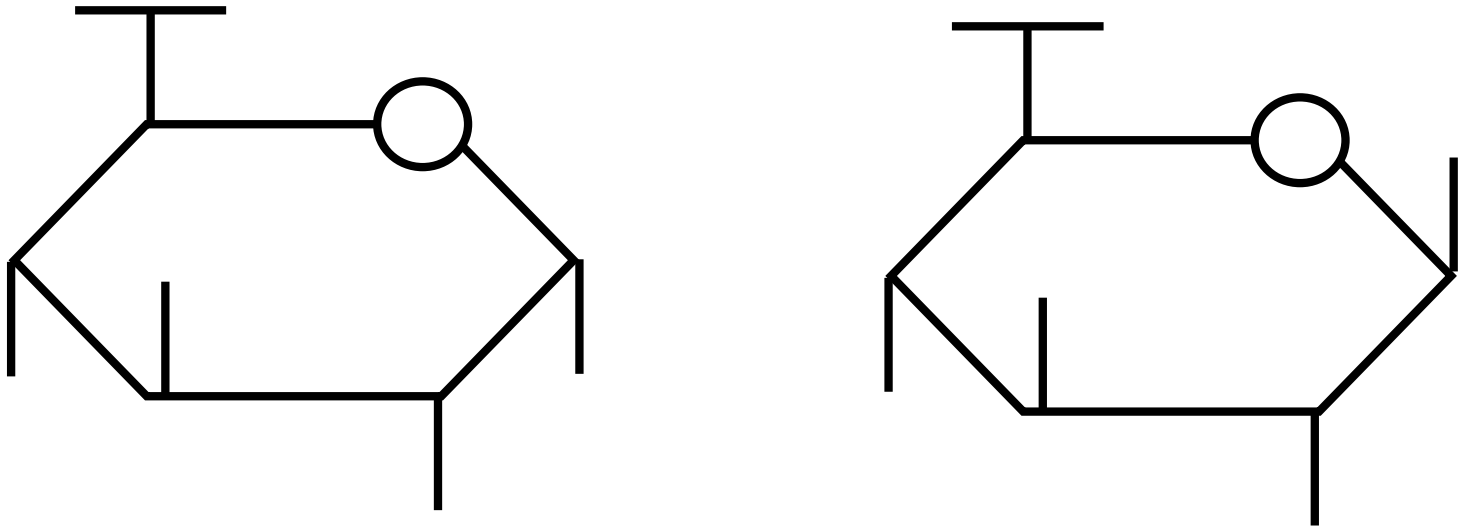
α anomer : opposite side with the side chain




α-D-glucose




β-D-glucose



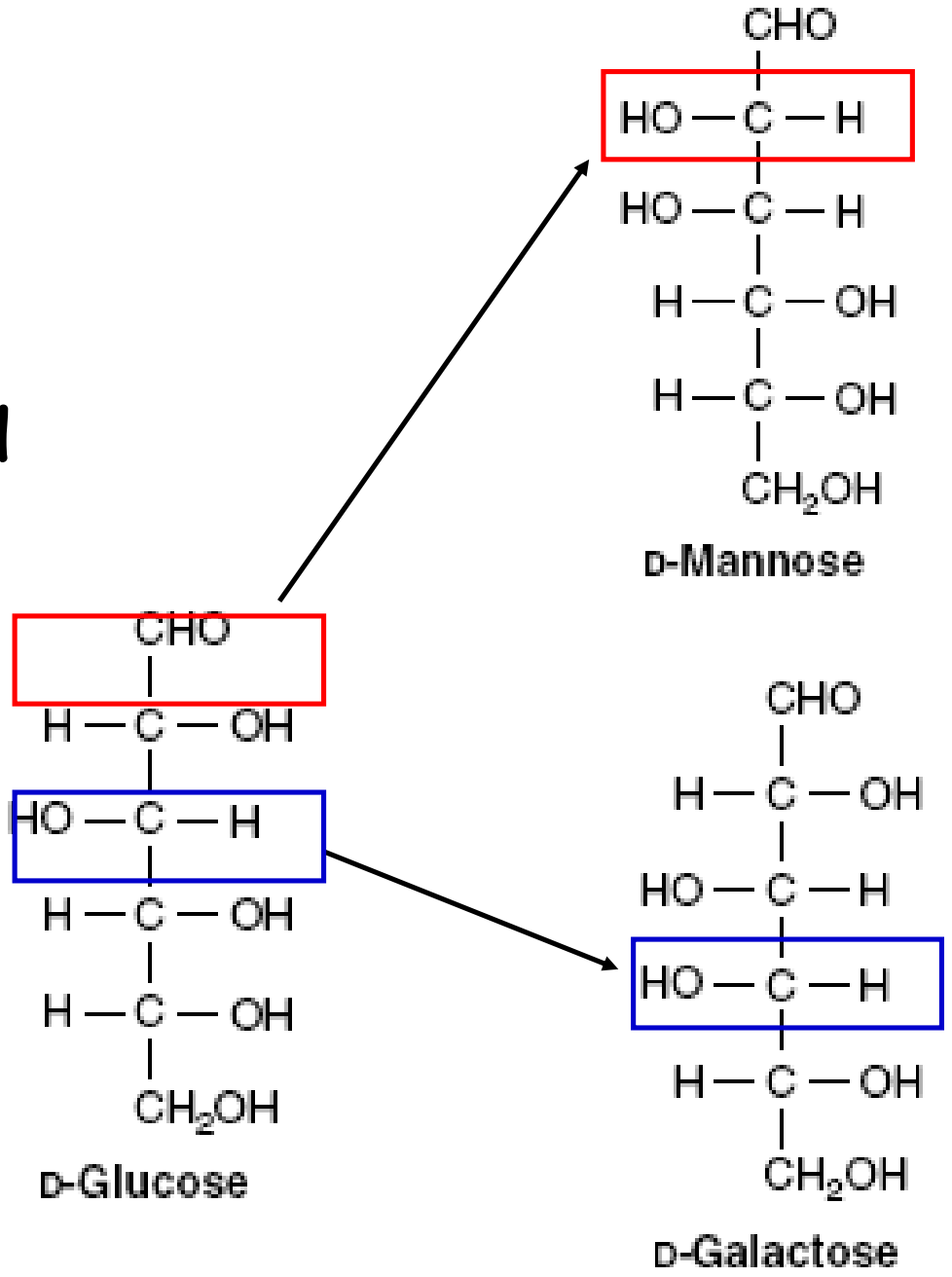
At equilibrium 1/3 will be α and 2/3 will be β anomer.

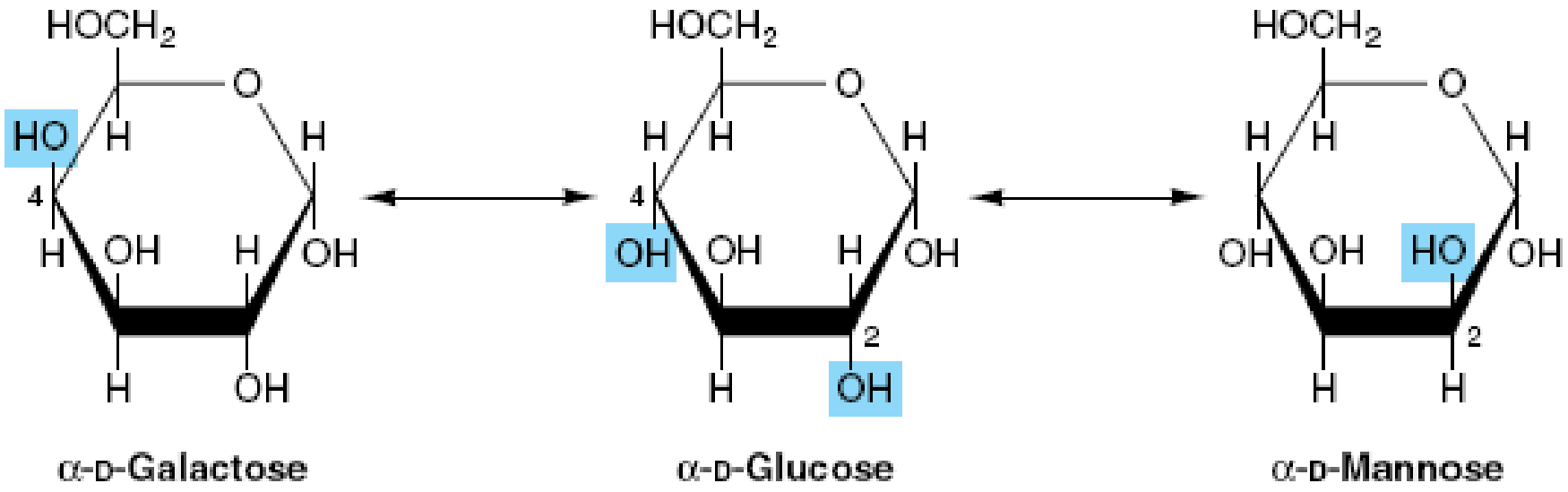
## 5) epimers

**EPIMERS:differ in conformation around ONE carbon**

**Man = 2-epimer of Glc**

**Gal = 4-epimer of Glc**






**Gal** is found in lactose (milk sugar)

**Galaltose and Mannose** are epimers of glucose